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Development of a USMC Officer Assignment Decision Support System: Economic Analysis

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13. ABSTRACT (Maximum 200 words)

This Economic Analysis (EA) was completed as part of the Life Cycle Management (LCM) process for development of an Officer Assignment Decision Support System (OADSS). This document provides information about costs associated with the two feasible alternatives for system development: (1) Existing System Enhancement; and (2) Distributed Processing--Minicomputer. System development costs are divided into nonrecurring and recurring cost categories while "sunk" costs are excluded. A weighted benefits analysis revealed that the Distributed Processing--Minicomputer alternative would yield more benefits than Existing System Enhancement (591 vs. 500). However, a cost/benefit analysis conducted utilizing the Benefit-to-Cost Ration (BCR) methodology indicated that the Existing System Enhancement alternative is preferable (1.60 vs. .94). Thus, while the Distributed Processing--Minicomputer alternative may be "ideal," it is significantly more costly and there is some question about the systems operation/maintenance capability of the Officer Assignment Branch (MMOA). It is recommended that a Functional Description (FD) be completed as the next phase in development of OADSS.

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FOREWORD

This report evaluates economic factors associated with alternative approaches to development of an Officer Assignment Decision Support System (OADSS) to improve current assignment in the United States Marine Corps (USMC). Among the deficiencies in the current assignment system are the labor-intensive review of hard copy-based information, need for a comprehensive and centralized data base, and lack of standardization among officer Monitors in their assignment strategies. Monitors critically need interactive, computer-based support for assignment decisions because of the volume of assignment-related information available and the vast number of assignment alternatives to be weighed. This economic analysis presents costs and benefits associated with the two alternatives to OADSS development deemed as feasible in the preceding feasibility study.

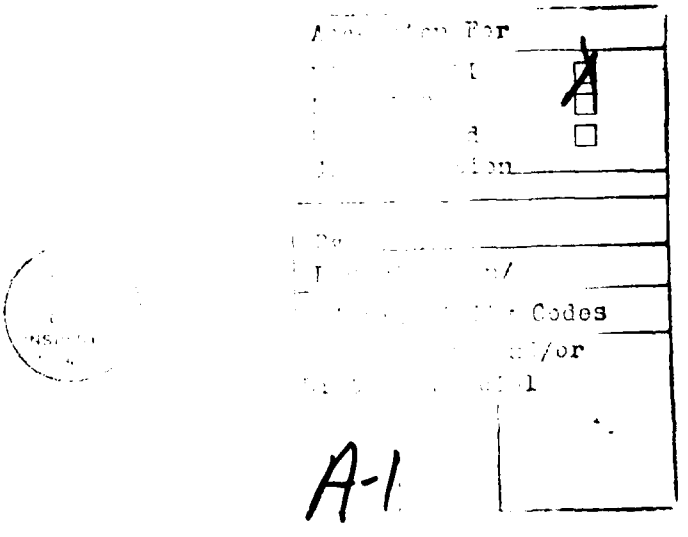
This is the third in a series of reports that detail the "definition and design" phase of the USMC Life Cycle Management (LCM) process associated with OADSS. The research was conducted under work unit number M5402688WRRD8FY, Marine Corps Decision Support System for Officer Assignment, sponsored by the Manpower Plans and Policy Division (MPI). This report is based upon the combined Feasibility Study/Economic Analysis (FS/EA) that was submitted to MPI in March, 1986. The present Economic Analysis has been completed to provide a guide for other researchers tasked with completing LCM documentation. Future reports will include a project management plan, a functional description, and system design specifications for OADSS development.

JOHN J. PASS
Director, Personnel Systems Department

Prior OADSS Publications:

Chatfield, R.E. (1988). Development of a USMC Officer Assignment Decision Support System: Needs Assessment (NPRDC) Tech. Note 88-50). San Diego: Navy Personnel Research and Development Center.

Chatfield, R.E., & Gullett, S.A. (1988). Development of a USMC Officer Assignment Decision Support System: Feasibility Study (NPRDC Tech. Note 89-14). San Diego: Navy Personnel Research and Development Center.



SUMMARY

Background

Officer Monitors need support in their decision-making process due to the vast amount of assignment-related information to be considered and the number of assignment alternatives to be weighed. It is anticipated that a user-friendly, interactive Officer Assignment Decision Support System (OADSS) will help Monitors better implement USMC staffing policy, significantly reduce their clerical workload, and enhance the match of officers to billets.

Methodology

Analysis of two feasible alternative approaches to OADSS development and implementation was conducted using generally accepted economic techniques. As identified in the preceding Feasibility Study, these alternatives are: (1) Alternative 2: Existing System Enhancement, and (2) Distributed Processing--Minicomputer. Emphasis was placed on providing a clear, concise comparison of costs and benefits associated with each alternative. Costs were considered either nonrecurring (i.e., system development and installation) or recurring (i.e., system operation and maintenance). Expected benefits of the system were weighted for relative importance to promote quantifiable comparison of the two alternative. Finally, a susceptibility analysis was conducted to gauge the extent to which alternatives are impacted by changes in assumptions or costs.

Objective

The objective of this economic analysis was to provide information to be used in determining the feasibility and advisability of continuing development of the OADSS. Both costs and benefits associated with the two feasible alternatives were provided so that decision-makers could evaluate which of them is more justified from a cost/benefit perspective. Specific information about user requirements and operational constraints may be found in the earlier Needs Assessment. Information about assessment of the four alternative approaches to system development evaluated may be found in the preceding Feasibility Study.

Cost Analysis

System development costs for each of the alternative approaches was analyzed with elements divided into nonrecurring and recurring cost categories. Nonrecurring costs were further divided into three additional categories: (1) hardware purchase, (2) software purchase and development, and (3) communications. Recurring costs were also further divided into three categories: (1) hardware maintenance and operations, (2) software maintenance, and (3) communications. Following USMC Life Cycle Management protocol, several "sunk costs" (see Assumptions in the Cost Analysis section) were not included in this analysis. Hardware costs presented in Alternative 2 represent only a small portion of the extensive mainframe environment upgrade required to meet user needs. For Alternative 2 to be considered viable, the assumption must be made that the Marine Corps Central Design and Programming Activity (MCCDPA), Quantico, will introduce upgrades in a timely fashion.

Benefits Analysis

A "weighted" benefits analysis was conducted, which focused upon the following benefits that will arise from OADSS implementation: (1) system ease-of-use, (2) system responsiveness and reliability, (3) reduction in manual, labor-intensive practices, (4) expanded data element access, (5) improved Monitor training, (6) improved Officer Staffing Goal Model (OSGM) procedures, (7) system growth potential, and (8) better "customer service." Alternative 3 received a higher overall score (591 vs. 500) than Alternative 2, thanks mainly to high marks on system ease-of-use, system responsiveness, and growth potential.

Cost/Benefit Analysis

A cost/benefit analysis of the two alternatives for system development was conducted using a Benefit-to-Cost (BCR) approach. This procedure required completing a Present Value Analysis to establish Uniform Annual Costs across a 5-year period. Alternative 2 (1.60) was found to have a significantly higher BCR than

Alternative 3 (.94). While alternative 3 yields greater benefits, it requires over twice the average annual expenditure for system maintenance.

Sensitivity Analysis

A sensitivity analysis was conducted to assess the impact of changes in assumptions (e.g., estimated benefits) or costs used in conducting the economic analysis. This procedure reflects how resistant the analysis is to errors in estimation, bias, changes in technical environment, etc. that may arise prior to system implementation. While the differential in system development costs for the two alternatives was greatly reduced, the recalculated BCR indicated that Alternative 3 still remained too costly from a cost/benefit perspective.

Conclusions

Based on this economic analysis, the following conclusions were reached:

1. Alternative 3 yields approximately 20 percent greater benefits that Alternative 2 but is substantially more costly since it involves installation of a MMOA-dedicated minicomputer system. Overall, Alternative 2 had a significantly higher Cost-to-Benefit Ratio (1.60 vs. .94) than Alternative 3.

2. The sensitivity analysis indicated that the difference in costs for the two alternatives can be reduced somewhat if existing ADP equipment (i.e., VDTs, printers) is used in Alternative 3 and/or software development costs are introduced for Alternative 2. However, as revealed by the recalculated Benefit-to-Cost Ratio, Alternative 2 remained much more economically feasible.

3. Alternative 2 is recommended for implementation of the Officer Assignment Decision Support System (OADSS). Major enhancements to the AMDAHL V/8 are in progress and will continue to be made over the next 3-year period. The assumptions is that these major enhancements will yield the improved system response time required for Monitors' ad hoc query of data bases. A DBMS utilizing Application Generator technology and other user-friendly features, FOCUS, has recently been installed at the MCCPDA at a cost of $130,000. Utilization of FOCUS would be a good use of existing resources and minimize software costs. MMOA will be fully supported by MCCDPA personnel in developing DBMS applications, modifying data bases, and other tasks pertaining to the operation and maintenance of OADSS. Therefore, MMOA-3 personnel will not be overwhelmed with new responsibilities associated with the proposed system.

4. Alternative 3 represents the ideal environment for OADSS implementation. A "modular" minicomputer dedicated to MMOA processing could grow to meet branch needs and would ensure rapid response to data base queries. However, this alternative cannot be recommended at the present time for two reasons:

a. The ADP equipment could not be purchased through the POM process expeditiously enough to be utilized in this OADSS effort that concludes FY89. OADSS funds are in the R,D,T,&E category so cannot be used for a minicomputer or similar ADPE purchases.

b. Installation, operation, and maintenance of a minicomputer is likely too much for MMOA to handle, based on current manning levels. While the three MMOA-3 Systems Support personnel have the technical expertise to meet these demands, they are already working at full capacity. As manpower resources for HQMC are "capped," it is unlikely that MMOA will receive additional qualified personnel in the near future.

Therefore, while this Alternative 3 has the potential to be operationally superior to the recommend alternative, the two aforementioned factors makes its selection infeasible at the present time.

CONTENTS

LIST OF FIGURES

INTRODUCTION

Background

The mission of the Officer Assignment Branch (MMOA), located at Headquarters, USMC (HQMC) is to administer assignment of all Marine Corps officers (Colonel and below) in accordance with regulations, approved assignment policies, and criteria of the Commandant of the Marine Corps (CMC). Functions carried out in support of this mission include: issuing travel orders; classifying/reclassifying officers in occupational specialties; and assigning officers to educational, intermediate, and top level schools. The individuals within MMOA who make assignment decisions (subject to approval by higher authority) are referred to as officer "Monitors." Monitors have a very difficult job in that they are expected to accommodate both the manning requirements of the Marine Corps and the career/personal needs of officers via the assignment process. Performing this task requires concurrent consideration of the job dimensions of available billets and the skills and attributes of officers being assigned.

Monitors' first consideration in staffing is the "fill" of available billets while the next is the "fit" of officers to specific billets based upon their education, work experience, military occupational specialty (MOS), etc. The process of reaching an assignment decision may involve accessing on-line personnel data bases such as the Joint Uniform Military Pay System/Manpower Management System (JUMPS/MMS), reviewing Officer Fitness Reports (FITREPS) on microfiche, talking with constituents in person or on the telephone, or reviewing a number of other relevant sources of information. In conjunction with this, Monitors must also be mindful of established staffing policy, USMC manning levels, and the career development needs of individual officers when weighing assignment alternatives.

The idea for establishing an Officer Assignment Decision Support System (OADSS) came about because it was evident that Monitors need support in their decision-making process due to the vast amount of assignment-related information to be considered and the number of assignment alternatives to be weighed. It is anticipated that a truly user-friendly, interactive Decision Support System (DSS) will help Monitors better implement USMC staffing policy, significantly reduce the clerical workload of Monitors, and enhance the match of officers to billets.

The original effort to develop a DSS for Monitors was carried out by a contractor as part of the Officer Precise Personnel Assignment System (Officer PRE-PAS) in 1979. However, this work stressed an optimization approach to officer assignment and was terminated in the early concept development stage of the Life Cycle Management (LCM) process. A subsequent contractor effort to build OADSS, in 1981, was also terminated in the concept development stage as it also relied too heavily upon optimization techniques and was not sufficiently interactive. Both of these attempts were doomed to failure as the Marine Corps objected to any "black box" (i.e., optimization) approach perceived to automate the assignment process. The goal was to support Monitors in their decision-making, not to make assignment decisions for them.

The idea for developing the OADSS lay dormant until 1985 when support for a third attempt at system development became available at the Navy Personnel Research and Development Center (NPRDC). The project sponsor, Manpower Plans and Policy (MPI), specified that system design be carried out by Personnel Research Psychologists rather than Operations Researchers or Computer Specialists under the assumption that this would avoid yet another optimization-oriented approach that would prove unacceptable to the CMC. Also, it was MPI's assumption that the psychologists could better assess Monitors' needs and translate them into design of a system that was easy to access and truly user-friendly.

In compliance with the USMC Life Cycle Management Plan for Automated Information System (U.S. Marine Corps, 1983), a combined Feasibility Study/Economic Analysis (FS/EA) was submitted to MPI in March, 1986. This document examined four system development alternatives and provided the basis for the preceding Feasibility Study (FS) (Chatfield & Gullett, 1988). Taken together, the FS and EA documents provided the Marine Corps with a means of evaluating the merits of proceeding with subsequent "Definition and Design" phases. This Economic Analysis is also based upon the FS/EA submitted to MPI and has been completed to provide a guide for other researchers tasked with completing LCM documentation.

Methodology

Analysis of the two feasible alternative approaches to OADSS development and implementation was conducted using generally accepted economic analysis techniques. Emphasis was placed on providing a clear, concise comparison of costs and benefits associated with each alternative. Costs were considered either

nonrecurring (i.e., system development and installation) or recurring (i.e., system operation and maintenance). Expected benefits of the system were weighted for relative importance to promote quantifiable comparison of the two alternatives. Finally, a susceptibility analysis was conducted to guage the extent to which alternatives are impacted by changes in assumptions or costs.

Objective

The overall objective of this economic analysis is to provide information to be used in determining the feasibility and advisability of continuing development of the OADSS. Both costs and benefits associated with the two feasible alternatives will be provided so that decision-makers can evaluate which of them is more justified from a cost-benefit perspective. Specific information about user requirements and operational constraints may be found in the earlier Needs Assessment. Information about assessment of the four alternative approaches to system development evaluated may be found in the preceding Feasibility Study.

Assumptions

The following assumptions were made in conducting the economic analysis:

1. The economic life cycle of the OADSS is 5 years from the date of full implementation.

2. The base year for cost analysis is fiscal year 1986.

3. System development costs (hardware procurement) will be incurred in FY87, but only a portion of the full system was in place by the end of that fiscal year.

4. The use of existing Marine Corps Central Design and Programming Activity (MCCDPA), Quantico, computer resources are treated as "sunk costs" and are not included.

5. Concept or system development costs incurred to date are treated as "sunk costs" and are not included.

6. Costs associated with the Navy Personnel Research and Development Center's (NPRDC) project manager's planning and management of system implementation is not included.

7. For Alternative 3, the assumption was made that MMOA will continue to be located at HQMC because plans for a projected move to the MCCDPA, Quantico are uncertain at this time.

8. For Alternative 3, the AMDAHL mainframe will have ports available for communicating with the compatible minicomputer.

9. For Alternative 3, vendor support and some special programming will be required for implementation.

10. For Alternative 3, hardware maintenance will be carried out by the vendor on a contract basis.

11. Software maintenance will typically be carried out by the vendor under a maintenance plan offered. However, the expertise and availability of in-house personnel will be considered when determining who will be responsible for specific software maintenance.

12. Hardware and software costs are based on the most current General Services Account (GSA) schedules.

13. Manpower costs under each alternative are equal. However, some ADP background is desirable for MMOA-3 (Systems) personnel in Alternative 3.

14. Labor rates used for software estimates are $50.00 per hour with one man-month having 152 hours.

15. Upgrading mainframe hardware under Alternative 2 will be cost prohibitive in terms of OADSS funding. Therefore, costs reflect only a small portion of the hardware expenditure (four microcomputers) that will actually be required for the alternative to be viable.

16. Nonrecurring costs associated with Alternative 3 could be substantially reduced by eliminating various purchases (e.g., 20 VDTs) and using existing equipment.

17. The possibility of Monitors using portable computers for on-site constituent visits will be investigated under both alternatives. However, no cost estimates have been included as a prototype procedure must first be developed.

Alternatives

A description of the four alternatives evaluated in terms of their potential for meeting technical, operational, and user requirements are presented in the Feasibility Study. The Existing System (Alternative 1) and Distributed Processing--Microcomputer LAN (Alternative 4) alternatives are not presented here because of their assessed infeasibility. The two alternatives evaluated are:

Alternative 2: Upgrading existing centralized, mainframe processing with hardware/software enhancements. This alternative is hereafter referred to as Existing System Enhancement.

Alternative 3: Distributed processing using a combination of mainframe and minicomputer processors. This alternative is hereafter referred to as Distributed Processing--Minicomputer

COST ANALYSIS

Background

Elements in the cost analysis are divided into two categories: (1) nonrecurring costs, and (2) recurring costs. Nonrecurring costs are one-time expenses involved with system implementation and integration. Conversely, recurring costs begin after system implementation and pertain to operations and maintenance. Several "sunk costs" (see Assumptions) are not included in this cost analysis. Hardware costs presented for Alternative 2 represent only a small portion of the extensive mainframe environment upgrade required to meet user needs. For Alternative 2 to be considered viable, the assumption must be made that the MCCDPA, Quantico, will introduce required upgrades in a timely fashion. Refer to Figure 1 for a summary of costs associated with the two alternatives. Figure 2 presents the same information but in a graphical form that facilitates quick comparison of the alternatives.

Nonrecurring Costs

Nonrecurring costs required at initiation of the system development life cycle are divided into three categories: (1) hardware purchase, (2) software purchase and development, and (3) communications. The following paragraphs describe the costs in these categories for each alternative.

Hardware Purchases

The following ADP equipment (hardware) costs will be incurred by the respective alternatives:

1. *Alternative 2: Existing System Enhancement.* As costs involved with upgrading the existing mainframe processor are prohibitive (in terms of OADSS funding), hardware purchases for this alternative are limited to four microcomputers and peripheral devices. The microcomputers must have the following characteristics: 640KB RAM, 20MB hard disk drive, 360KB double-sided diskette drive, monochrome monitor, graphics capability, and bisynchronous communications adaptor. The cost of each unit, based on current GSA prices, is approximately $4,700, yielding a total of $9,4000. The cost of peripheral devices (modems, printers, etc.) is estimated at approximately $800 per microcomputer, yielding a total of $1,600. Total hardware expenditure for this alternative is estimated at $11,000.

2. *Alternative 3: Distributed Processing--Minicomputer.* Under this alternative, a complete minicomputer system will be purchased for MMOA-dedicated processing. To ensure accuracy in cost estimation, a quotation for a complete 20-user minicomputer system was obtained from an industry leader in mainframe/-minicomputer equipment. The cost estimate (applying a 19% GSA discount) was based on a system with the following characteristics: 9MB RAM, 465MB of disk storage, 20 monochrome VDTs, 95MB tape backup sub-system, laser printer, and SNA communications capability. The total hardware cost for this alternative is $85,000. However, the subsequent sensitivity analysis will reflect how this amount can be substantially reduced.

Cost Element	FY87	FY88	FY89	FY90	FY91	TOTAL
NONRECURRING						
Hardware Purchase[1]						
Alternative 2	22,000					22,000
Alternative 3	85,000					85,000
Software Purchase						
Alternative 2	43,000					43,000
Alternative 3	23,500					23,500
Software Devel.						
Alternative 2	0					0
Alternative 3	16,250					16,250
Communications						
Alternative 2	8,000					8,000
Alternative 3	10,500					10,500
Sub-Total						
Alternative 2	73,000					73,000
Alternative 3	135,250					135,250
RECURRING[2]						
Hardware Maint.						
Alternative 2	2,400	2,640	2,904	3,194	3,514	14,652
Alternative 3	10,554	11,609	12,770	14,047	15,452	64,432
Software Maint.						
Alternative 2	5,500	6,050	6,655	7,320	8,053	33,578
Alternative 3	9,382	10,320	11,352	12,487	13,736	57,277
Communications						
Alternative 2	4,000	4,400	4,840	5,324	5,856	24,420
Alternative 3	6,408	7,049	7,754	8,529	9,382	39,122
Sub-Total						
Alternative 2	11,900	13,090	14,399	15,838	17,423	72,650
Alternative 3	26,344	28,978	31,876	35,063	38,570	160,831
TOTAL COST						
Alternative 2	84,900	13,090	14,399	15,838	17,423	145,650
Alternative 3	161,594	28,978	31,876	35,063	38,570	296,081

[1]Does not include cost of upgrades to the AMDAHL mainframe.

[2]Assumes operations provided by Marine Corps personnel.

Alternative 2: Existing System Enhancement
Alternative 3: Distributed Processing--Minicomputer

Figure 1. Cost summary for feasible alternatives.

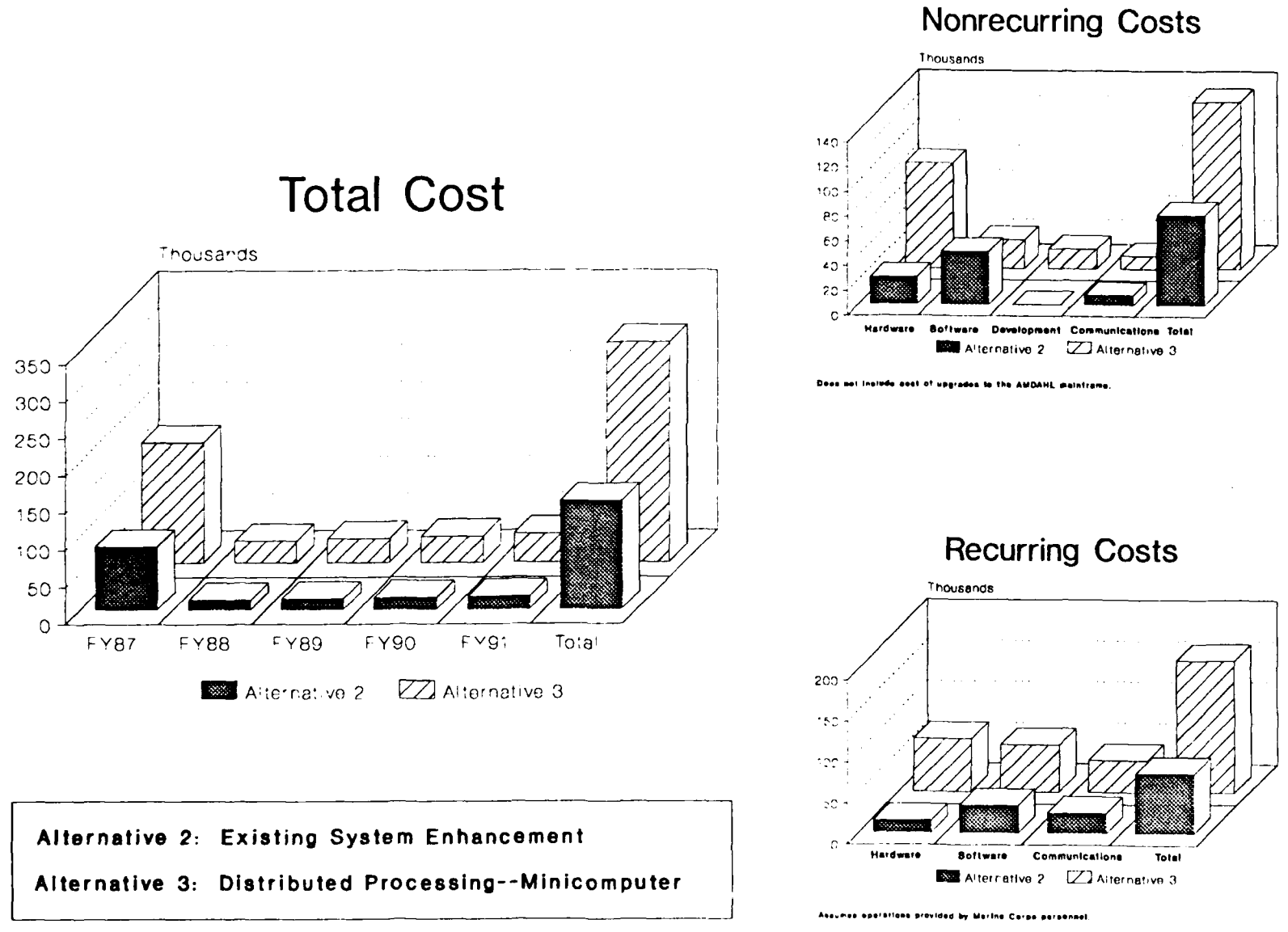


Figure 2. Graphical cost summary for feasible alternatives.

Software Purchase and Development

The following software purchase and development costs will be incurred by the respective alternatives:

1. *Alternative 2: Existing System Enhancement.* It is anticipated that software for this alternative will be purchased "off the shelf." Software requirements are for a mainframe user-friendly DBMS, faster downloading/uploading of data, and improved statistical analysis and reporting. Estimated cost for these purchases is $27,000. While FOCUS may be acceptable as the DBMS, purchase of additional FOCUS System Modules is anticipated.

2. *Alternative 3: Distributed Processing--Minicomputer.* Software requirements for this alternative include a user-friendly DBMS (for the minicomputer), minicomputer-to-mainframe communications, improved statistical analysis and reporting, a COBOL compiler, and the minicomputer operating system (vendor supplied). It is anticipated that the DBMS (with statistical capabilities) and the COBOL compiler will be purchased off the shelf while communications will require a combination of commercially available products and special programming. Cost is estimated at $23,500 for purchase and $16,250 for special programming, yielding a total expenditure of $39,750.

Communications

The following communications installation costs will be incurred by the respective alternatives:

1. *Alternative 2: Existing System Enhancement.* In order to provide more efficient maintenance of OSGM control files, a leased line communications link will be established between the MCCDPA, Quantico, and Computer Data Corporations's (CDC) ECC in Rockville, Maryland. Cost of installation is estimated at $8,000.

2. *Alternative 3: Distributed Processing--Minicomputer.* This alternative requires two new communication links to be installed: (1) from the MMOA minicomputer to the AMDAHL mainframe located at the MCCDPA, Quantico; and (2) from the MMOA minicomputer to the CYBER mainframe located at CDC Eastern Communications Center (ECC) in Rockville.

Recurring Costs

Recurring costs for the OADSS will stem principally from maintenance and operation of hardware/software components. Again, the costs are divided into categories: (1) hardware maintenance and operations, (2) software maintenance, and (3) communications. The following paragraphs describe these costs for each of the feasible alternatives. Maintenance support provided by USMC personnel is not included in the analysis. A graphical summary of recurring costs for a 5-year period is presented in Figure 3.

Hardware Maintenance and Operations

The following maintenance and operations costs will be incurred by the respective alternatives:

1. *Alternative 2: Existing System Enhancement.* Equipment maintenance costs are limited to vendor supplied maintenance of six microcomputers (two current and current new) and peripheral devices. The cost of such maintenance is estimated at $2,400 per year with a 10 percent annual inflation rate projected.

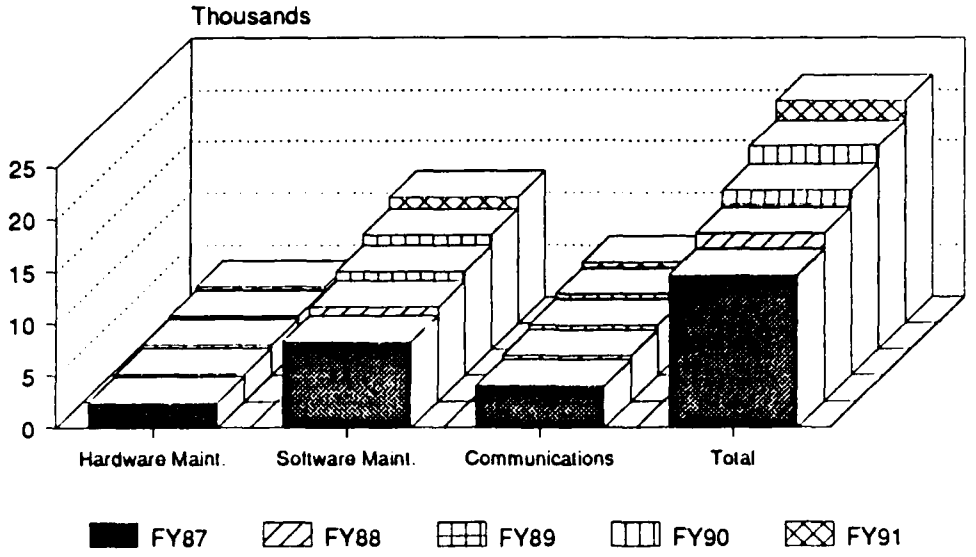
2. *Alternative 3: Distributed Processing--Minicomputer.* Maintenance of the minicomputer equipment will be vendor supplied. A field maintenance contract will cover the CPU, storage devices, tape backup sub-system, VDTs, communication devices, laser printer, and all other equipment. First year maintenance cost, based on the vendor supplied price quotation, is approximately $10,554. Out-year maintenance costs are provided with a 10 percent annual inflation rate assumed.

Software Maintenance

The following software maintenance costs will be incurred by the respective alternatives:

1. *Alternative 2: Existing System Enhancement.* Software maintenance will be provided by a standard maintenance plan offered by the vendor. Maintenance plans will cover the mainframe DBMS, communications software, and software used at the microcomputer level (e.g., R:base 5000). The maintenance

Alternative 2
Existing System Enhancement



Alternative 3
Distributed Processing--Minicomputer

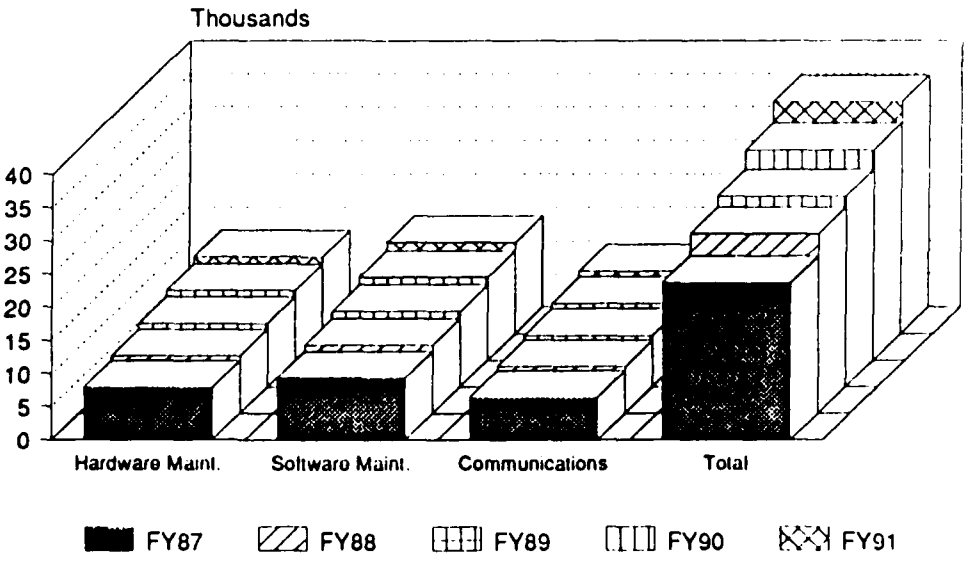


Figure 3. Summary of recurring costs for a 5-year period.

will ensure receipt of product upgrades and continued technical support. First year cost is approximately $5,500 with out-year estimates based on a 10 percent inflation factor.

2. *Alternative 3: Distributed Processing--Minicomputer.* Software maintenance required is similar to that of Alternative 2 with the additional requirement for maintenance of the minicomputer operating system, COBOL compiler, and contractor-developed communications programs. Based on vendor supplied maintenance charges and projecting contractor maintenance at $50 per hour, first year cost is estimated at $9,382. Out-year estimates are provided with a 10 percent inflation rate assumed.

Communications

The following recurring communications costs will be incurred by the respective alternatives:

1. *Alternative 2: Existing System Enhancement.* Recurring costs for communications will consist of charges for the leased line link between the MCCDPA, Quantico, and CDC's ECC. First year cost is estimated at $4,000 with out-year estimates based on a 10 percent annual inflation factor.

2. *Alternative 3: Distributed Processing--Minicomputer.* Recurring costs for communications will consist of charges for leased line links between: (a) MCCDPA, Quantico and MMOA (HQMC), and (b) CDC's ECC and MMOA (HQMC). First year cost is estimated at $6,408 with out-year estimates based on a 10 percent annual inflation factor.

BENEFITS ANALYSIS

Background

It is anticipated that a variety of benefits will arise from implementation of the OADSS. The purpose of this section is to summarize only the major benefits that the system will produce. For a broader perspective of projected benefits, refer to either the Needs Assessment or the Feasibility Study.

Benefits

This discussion focuses on eight major benefits that will result from OADSS implementation. While their order of presentation is not indicative of their importance, the first two benefits discussed are thought to be the most critical for system success. Benefits will be discussed both in terms of their content and the extent to which the two alternatives are expected to produce them.

System Ease of Use

Many Monitors currently avoid using computer resources because of "computer phobia" and/or because the system is not particularly easy to use effectively without extensive study and hands-on experience. The OADSS will include a user-friendly DBMS with applications generator, menu-driven program interfaces, on-line help facilities, and other features that promote ease-of-use. Both alternatives will provide this benefit. However, selection of a DBMS and other software for Alternative 2 will be somewhat constrained by hardware/software characteristics of the present system. Conversely, as Alternative 3 involves providing a new operating environment, ease-of-use considerations can be an important consideration at each stage of development.

System Responsiveness and Reliability

A critical deficiency in the present system is unacceptable system response time degradation during periods of heavy demand. OADSS will introduce hardware to promote rapid response to Monitor's queries with little response time degradation. Reliability of the current system is adequate (estimated 5% down time) and reliability of at least this level must be provided by the new system. It is presently impossible to estimate to what extent this benefit will be achieved by Alternative 2. Although the MCCDPA, Quantico is planning significant hardware upgrades over the next 3-year period, the extent to which these improvements will "filter down" to MMOA is uncertain. On the other hand, Alternative 3 provides a complete minicomputer system for MMOA-dedicated processing. Under this type of configuration, excellent system response time is virtually guaranteed. Such significant improvement in system response time will result in Monitors utilizing computer resources to a much greater extent then they do presently.

Reduction in Manual, Labor-Intensive Practices

Current assignment procedures are plagued by time-consuming manual processing and review of data elements. Increased utilization of user-friendly computer assistance will save time and free Monitors from these labor-intensive procedures. While both alternatives will provide this benefit, the extent to which it will be achieved depends mainly upon system response time and software selected.

Expanded Data Element Access

OADSS will expand the scope of data elements available to Monitors for review. That is, some data currently available only in hardcopy or microfiche form will be made available for computer access. In addition, the user-friendly DBMS will allow Monitors to review a wide variety of data elements quickly and easily. While both alternatives will provide this benefit, selection of the DBMS for Alternative 2 will be constrained somewhat by hardware/software characteristics of the present system.

Improved Monitor Training

Training materials and formalized training courses will be developed especially for Monitors. Training "modules" developed to cover such areas as formal staffing policy, DBMS usage, and Officer Staffing Goal Model (OSGM) procedures will help Monitors learn their job and will promote standardized assignment policies. Periodic refresher training will be provided and computer-based training (CBT) will be used where feasible. Both alternatives will provide this benefit. A number of users' manuals will be written for OADSS, irrespective of hardware/software considerations.

Improved OSGM Procedures

Direct communication with the CYBER mainframe at CDC's ECC will simplify preparation and maintenance of OSGM control files. Current paper-and-pencil update procedures will be replaced by on-line maintenance by Monitors. Monitors' input will be more carefully reviewed to promote production of valid OSGM staffing goals. Both alternatives will provide this benefit provided that the communications link to the CYBER is provided and appropriate software is available for OSGM control file maintenance.

System Growth Potential

The ease of upgrading the system to meet new and expanding MMOA requirements is clearly an important consideration. The system should not only satisfy current needs but be structured to allow future enhancements to be readily accomplished. Alternative 2 is not particularly well suited to produce this benefit as system growth is controlled by the MCCDPA, Quantico and HQMC (C4). In contrast, Alternative 3 will provide a "modular" minicomputer system that allows CPU and disk storage upgrades to be readily carried out. Under this alternative, MMOA will effectively control the extent and timing of future system upgrades.

Better Customer Service

The level of "customer service" that Monitors provide their constituents is critical. The OADSS will improve this area by providing a system that will allow Monitors to provide timely, accurate answers to constituents' questions. In addition, the use of portable computers for on-site visits will further enhance the quality of customer service. Both alternatives will provide this benefit to the extent that the system response time is fast and Monitors can easily conduct ad hoc queries and data extracts. However, it is anticipated that Alternative 3 will promote better customer service because the minicomputer will be dedicated to meeting the needs of MMOA; thereby ensuring rapid fast access to information.

Benefits Analysis

The "weighed" benefits analysis methodology used to compare the extent to which the two feasible alternatives will provide benefits is described below:

1. Each benefit was assigned a weight from 1 to 10 indicating its importance relative to the other benefits. The highest level of desirability was "10" with "1" being the lowest.

2. Each alternative was reviewed to determine how well it provides the respective benefits. Again, a 1 to 10 scoring procedure was used. A "1" rating indicated no improvement over the existing assignment system while a "10" indicated highly significant improvement.

3. Scores for the two ratings were cross-multiplied to derive a weighted score for each alternative on each benefit. A total score was computed for each alternative by summing weighted scores across the eight benefits.

Results of the weighted benefits analysis is presented in Figure 4. Alternative 3 received a higher overall score (591 vs. 500) than Alternative 2 due principally to system ease-of-use, system responsiveness, and potential for growth. In fact, Alternative 3 had a score which was equal to or higher than that for Alternative 2 on each of the benefits. Figure 5 presents a graphical summary of findings from the benefits analysis.

Benefit	Relative Weight	Score		Weighted Score	
		Alt2	Alt3	Alt2	Alt3
System Ease of Use	10	8	10	80	100
System Responsiveness and Reliability	10	7	10	70	100
Reduction in Manual, Labor-intensive Practices	8	7	8	56	64
Expanded Data Element Access	8	8	8	64	64
Improved Monitor Training	9	9	9	81	81
Improved OSGM Procedures	7	7	8	49	56
System Growth Potential	6	6	9	36	54
Better Customer Service	8	8	9	64	72
Total Score:				500	591

Alternative 2: Existing System Enhancement
Alternative 3: Distributed Processing--Minicomputer

Figure 4. Benefits analysis summary.

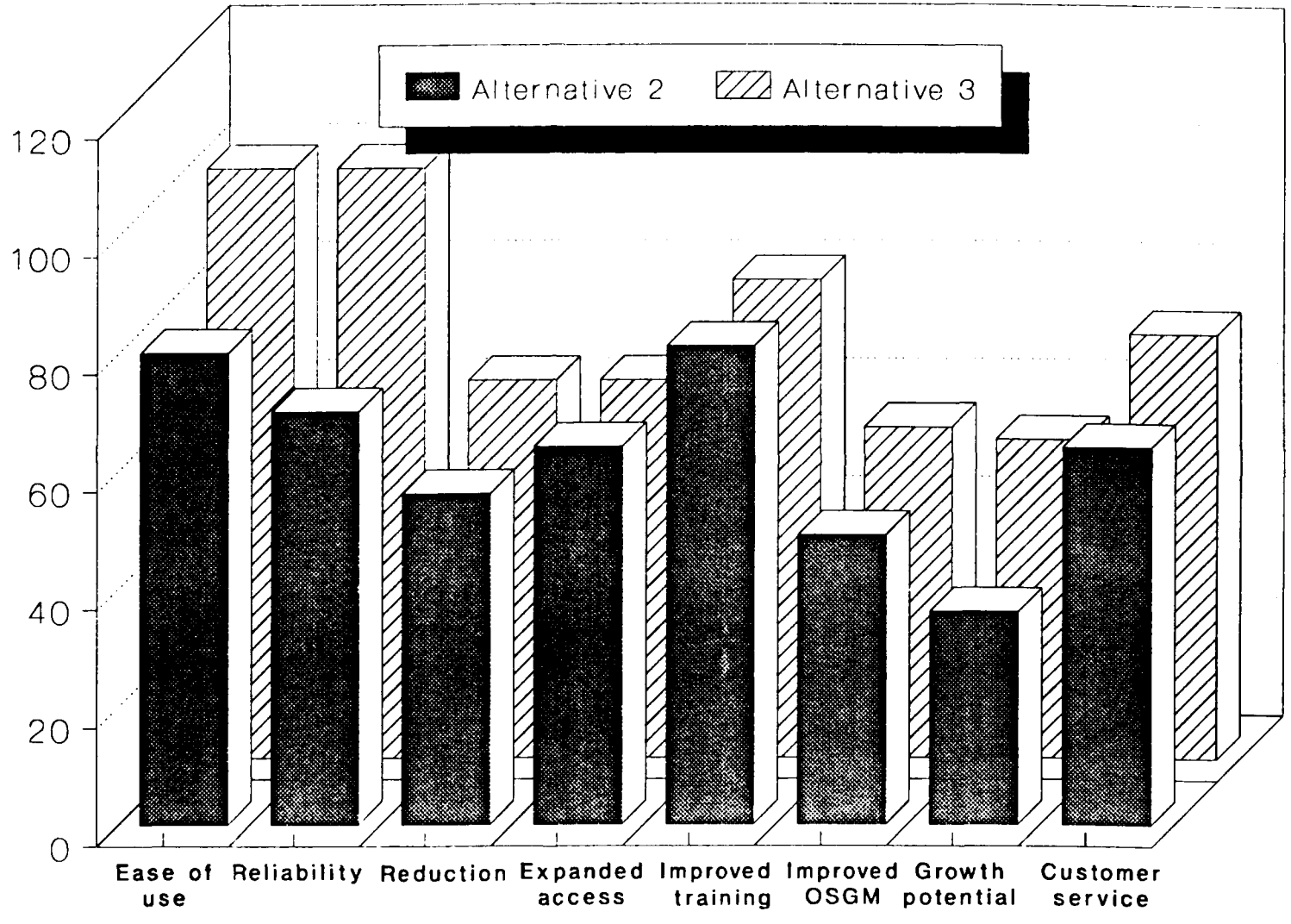


Figure 5. Graphical benefits analysis summary.

COMPARISON OF ALTERNATIVES

Background

Based upon analyses conducted thus far, the two feasible alternatives have been found to have unequal costs and benefits. Specifically, Alternative 2 is substantially less costly (assuming hardware upgrades are provided by the MCCDPA) while Alternative 3 yields greater benefits. A cost/benefit analysis was performed to better evaluate alternatives.

Cost/Benefit Analysis

There are a plethora of methods available for conducting cost/benefit analyses but the Benefit-to-cost Ratio (BCR) approach used here is often recommended for comparing diverse projects when there are constraints on capital investment (i.e., research funding) (Sassone & Schaffer, 1978). The advantage to using the BCR approach is that it provides a "standardiztion" method of comparing annual costs for the alternatives evaluated. However, as it is quite sensitive to the definition of benefits and the definition of costs, a follow-on sensitivity analysis was conducted to "validate" the findings when a few new cost assumptions were made.

The first step in the BCR analysis was to conduct a Present Value Analysis. Present Value factors were derived by discounting life cycle costs at 10 percent annually over a 5-year period and a 10 percent annual inflation factor was used for estimating recurring costs. Next, annual discounted costs were derived by multiplying each year's undiscounted cost by its present value factor. These costs ere then summed over the 5-year period to yield overall discounted costs for the two alternatives. Figure 6 summmarizes results of the Present Value Analysis.

Cost Category	FY1	FY2	FY3	FY4	FY5	Total Discounted Cost
Undiscounted Costs[1]						
Alternative 2	84,900	13,090	14,399	15,838	17,423	145,650
Alternative 3	161,594	28,978	31,876	35,063	38,570	296,081
Present Value Factor[2]	1.0	.954	.867	.788	.717	
Discounted Costs						
Alternative 2	84,900	12,488	12,484	12,480	12,492	134,844
Alternative 3	161,594	27,645	27,636	27,630	27,655	272,160

[1]Annual inflation rate of 10% assumed
[2]Discount rate of 10% assumed

Figure 6. Present value analysis: Discounted annual costs.

As the next stage in the const/benefit analysis, the total discounted cost for each alternative was divided by the sum of the present value factores (4.326) for the 5-year period. This resultant value is referred to as the Uniform Average Cost and provides an "average" annual cost index. The final step was to derive the benefit-to-cost ratio (BCR) by dividing quanti-year period to yield overall discounted costs for the two alternatives. The final step in the analysis was to derive the BCR by dividing the quantified benefitss (see Figure 4) of each alternative by its Uniform Annual Cost and multiplying the result by 100.

Results

Alternative 2 (2.01) was found to have a higher BCR than Alternative 3 (.94). While Alternative 3 yields greater benefits (18.2% more than Alternative 2), it requires approximately over twice the average annual expenditure to maintain the system developed. Refer to Figure 7 for an overall summary of the BCR analysis.

Alternative	Discounted Cost	Uniform Average Cost[1]	Benefit Score	BCR[2]
2	134,844	31,171	500	1.60
3	272,160	62,913	591	.94

[1]Uniform Average Cost (UAC) = $\frac{\text{Total Discounted Cost}}{\text{Cumulative Discount Factor}}$

[2]Benefit to Cost Ratio (BCR) = $\frac{\text{Quantified Benefits}}{\text{UAC}} \times 100$

Figure 7. Benefit-to-cost (BCR) summary.

SENSITIVITY ANALYSIS

Purpose

The purpose of this sensitivity analysis is to assess the impact of changes in assumptions or costs used in conducting the economic analysis. This analysis reflects how resistant the economic analysis is to errors in estimation, bias, changes in the technical environment, etc. that may arise prior to system implementation.

Analysis

The cumulative impact of changing the following assumptions and costs was evaluated:

1. The cost of 20 VDTs and their maintenance was removed from Alternative 3 under the assumption that present equipment may be used.

2. Hardware costs (CPU and disk storage) for Alternative 3 were reduced 20 percent to reflect lower costs that may result from technological innovation.

3. Software development costs for Alternative 2 equal to those of Alternative 3 were introduced. Software maintenance for Alternative 2 was increased by 50 percent to cover the additional software.

The first two assumptions were used in the analysis because they take into account of the present ADP environment at HQMC and anticipated price reductions in ADP equipment associated with innovations in the computer industry. The third assumption was introduced to cover the expenditure on a mainframe-based DBMS if FOCUS proved unacceptable.

Results

Results of the sensitivity analysis are presented in Figure 8. It is readily apparent that by introducing the aforementioned changes, the cost of the two alternatives becomes much more comparable. Overall, the cost between them was reduced by 57 percent. Figure 9 presents the same information but in a graphical form that facilitates quick comparison of the alternatives.

Cost Element	FY87	FY88	FY89	FY90	FY91	TOTAL
NONRECURRING						
Hardware Purchase[1]						
Alternative 2	22,000					22,000
Alternative 3	60,807					60,807
Software Purchase						
Alternative 2	43,000					43,000
Alternative 3	23,500					23,500
Software Devel.						
Alternative 2	16,250					16,250
Alternative 3	16,250					16,250
Communications						
Alternative 2	8,000					8,000
Alternative 3	10,500					10,500
Sub-Total						
Alternative 2	89,250					89,250
Alternative 3	111,057					111,057
RECURRING[2]						
Hardware Maint.						
Alternative 2	2,400	2,640	2,904	3,194	3,514	14,652
Alternative 3	7,914	8,705	9,576	10,534	11,587	48,316
Software Maint.						
Alternative 2	8,250	9,075	9,982	10,981	12,079	50,367
Alternative 3	9,382	10,320	11,352	12,487	13,736	57,277
Communications						
Alternative 2	4,000	4,400	4,840	5,324	5,856	24,420
Alternative 3	6,408	7,049	7,754	8,529	9,382	39,122
Sub-Total						
Alternative 2	14,650	16,115	17,726	19,499	21,449	89,439
Alternative 3	23,704	27,074	28,682	31,550	34,705	145,715
TOTAL COST						
Alternative 2	103,900	16,115	17,726	19,499	21,449	178,689
Alternative 3	134,761	27,074	28,682	31,550	34,705	245,818

[1]Does not include cost of upgrades to the AMDAHL mainframe.

[2]Assumes operations provided by Marine Corps personnel.

Alternative 2: Existing System Enhancement
Alternative 3: Distributed Processing--Minicomputer

Figure 8. Sensitivity analysis summary.

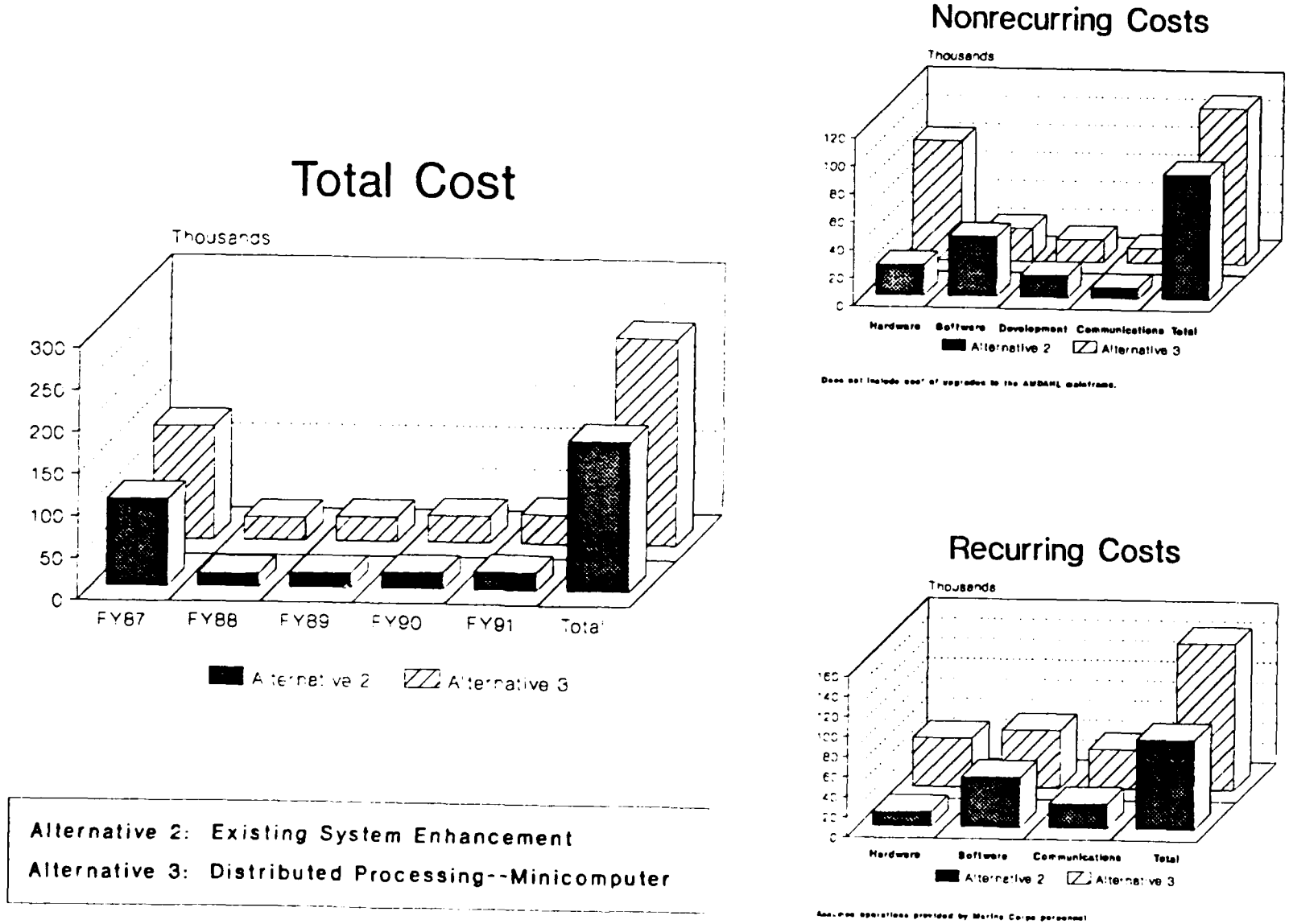


Figure 9. Graphical sensitivity analysis summary.

To ensure that the results from the sensitivity analysis were fully comparable with the preceding cost/benefit analysis, both the Present Value Analysis and BCR were recalculated as well. The Present Value Analysis is presented in Figure 10 and reveals that the cost differential in toal discounted cost was reduced by approximately 9 percent. Figure 11 summarizes the revised BCR, which indicated that the differential between the two alternatives was reduced by .12 when the three assumptions were incorporated. While the converging cost of system development for the two alternatives is perhaps noteworthy, the change in the BCR is not significant enough to merit recommending Alternative 3.

Cost Category	FY1	FY2	FY3	FY4	FY5	Total Discounted Cost
Undiscounted Costs[1]						
Alternative 2	103,900	16,115	17,726	19,499	21,449	178,689
Alternative 3	134,761	27,074	28,682	31,550	34,705	245,818
Present Value Factor[2]	1.0	.954	.867	.788	.717	
Discounted Costs						
Alternative 2	84,900	15,374	15,368	15,365	5,379	146,386
Alternative 3	161,594	25,829	24,867	24,861	24,883	262,034

[1]Annual inflation rate of 10% assumed
[2]Discount rate of 10% assumed

Figure 10. Present value analysis for the sensitivity analysis: Discounted annual costs.

Alternative	Discounted Cost	Uniform Average Cost[1]	Benefit Score	BCR[2]
2	146,386	33,839	500	1.48
3	262,034	60,572	591	.98

[1]Uniform Average Cost (UAC) = $\frac{\text{Total Discounted Cost}}{\text{Cumulative Discount Factor}}$

[2]Benefit to Cost Ratio (BCR) = $\frac{\text{Quantified Benefits}}{\text{UAC}} \times 100$

Figure 11. Benefit-to-cost (BCR) summary for sensitivity analysis.

CONCLUSIONS

Based on the present economic analysis conducted for the development of the Officer Assignment Decision Support System (OADSS), the following conclusions were reached:

1. Alternative 3 yields approximately 20 percent greater benefits than Alternative 2 but is substantially more costly since it involves installation of a complete minicomputer system. Overall, Alternative 2 had a significantly higher BCR (1.60 vs. .94) than Alternative 3.

2. The sensitivity analysis indicated that the difference in costs for the two alternatives can be markedly decreased if existing ADP equipment (i.e., VDTs, printers) is used in Alternative 3 and/or software development costs are introduced for Alternative 2. However, as revealed by the recalculated BCR, Alternative 2 remained much more economically feasible.

3. Alternative 2 is recommended for implementation of the OADSS. Major enhancements to the AMDAHL V/8 are in progress and will continue to be made over the next 3-year period. The assumption is that these major enhancements will yield the improved system response time required for Monitors' ad hoc query of data bases. A DBMS utilizing Application Generator technology and other user-friendly features, FOCUS, has recently been installed at the MCCDPA at a cost of $130,000. Utilizing of FOCUS would be a good use of existing resources and minimize software costs. MMOA will be fully supported by MCCDPA personnel in developing DBMS applications, modifying data bases, and other tasks pertaining to the operation and maintenance of OADSS. Therefore, MMOA-3 personnel will not be overwhelmed with new responsibilities associated with the proposed system.

4. Alternative 3 represents the ideal environment for OADSS implemenation. A "modular" minicomputer dedicated to MMOA processing could grow to meet branch needs and would ensure rapid response to data base queries. However, this alternative cannot be recommended for two reasons:

a. The ADPE equipment could not be purchased through the POM process expeditiously enough to be utilized in this OADSS effort that concludes in FY89. OADSS funds are in the R,D,T, & E category so cannot be used for a minicomputer or similar ADPE purchases.

b. Installation, operation, and maintenance of a minicomputer is likely too much for MMOA to handle, based on current manning levels. While the three MMOA-3 systems support personnel have the technical expertise to meet these demands, they are already working at full capacity. As manpower resources for HQMC are "capped," it is unlikely that MMOA will receive additional qualified personnel in the near future.

Therefore, while this alternative may be operationally superior to the recommended alternative, the two aforementioned factors makes its selection inadvisable at this time.

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